Portage Creek Superfund Site

Kalamazoo, Michigan

PCB Mass, Volume, and Surface-Weighted Average Concentration Estimates

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Introduction

Between 1993-1997 and 2008-2011, sampling was conducted by ARCADIS, the Michigan Department of Environmental Quality (MDEQ), and Weston Solutions throughout Portage Creek in order to characterize PCB concentrations. During these sampling events, soil and sediment core samples were collected across the floodplain and creek at different depths to assess areas with high levels of PCB contamination. The purpose of this report is to estimate the average concentration of PCB contamination within the top six inches of sediment in areas that will and will not be remediated per the action plan. Secondly, this report presents the estimates of mass and volume that will be removed in the proposed excavation areas. Additionally, estimates of the mass of PCB that will remain in these excavated areas is provided.

Methods

Data Handling and Subsetting for Surface Concentrations

Using the entire sample data collected from 1993-2011, a query was performed to select PCB sample results where the sample start depth was less than 6 inches. From this selection, the maximum PCB result per unique sample location was selected from this depth interval (0-6 inches) for instances in which there were more than one interval in the top six inches (e.g. 0-2, 2-10). These data were used to estimate surface-weighted average concentrations in Portage Creek, as well as by remediated and non-remediated areas within the creek.

Surface-Weighted Average Concentrations

Using the FIELDS Tools for ArcGIS software, a Natural Neighbor interpolation on these maximum PCB values in the 0-6 inch interval was performed across Portage Creek using a buffer polygon to encompass both the river boundary and the SA7 floodplain. Afterwards, the interpolation was clipped to each individual remediation and non-remediated area to estimate the mean PCB concentration from these interpolated values.

The surface-weighted averages were calculated using the following equation:

$$\frac{(\text{Result A} \times \text{Surface Area A}) + (\text{Result B} \times \text{Surface Area B}) + \ldots + (\text{Result Z} \times \text{Surface Area Z})}{(\text{Surface Area A} + \text{Surface Area B} + \ldots + \text{Surface Area Z})}$$

Total PCB Mass and Volume for Excavation Areas

To calculate the maximum PCB mass and volume, each remediation area was subdivided into excavation areas each with a surface area of approximately 2250 ft^2. For example, in Figure 2, Grid ID SA6-1 is an excavation area for remediation area SA6. The most downstream portion of each excavation area contained the remainder of the surface area as each excavation area could not be perfectly divided into an area with exactly 2250 ft^2. The maximum PCB value per sample location was queried out of the entire data set at one-foot intervals from 0-5 feet. Interpolation grids were then created using the Natural Neighbor interpolator in the FIELDS Tools for ArcGIS for each one-foot interval. After creating these interpolated grids, the FIELDS Remediation and Mass/Volume Tool was used to estimate mass and volume based on the interpolated PCB concentrations within each excavation area and its designated dredge depth.

Results and Discussion

PCB Average Surface Concentrations

Table 1 shows the average of the interpolated PCB values in the depth interval 0-6 inches (the surface-weighted average) across all of Portage Creek, as well as for the proposed remediation areas and areas not to be remediated. A visual breakdown of these areas can be seen in Figure 1. For the remediation areas, the pre-remediation PCB surface-weighted interpolated average is 9.72 mg/kg, while the surface-weighted interpolated average for just the non-remediated areas is 3.07 mg/kg (see Table 1). The pre-remediation PCB surface-weighted interpolated average concentration in the entire study area of Portage Creek is 6.06 mg/kg. If removing SA7 (which is not located in the river system), the pre-remediation PCB surface-weighted average concentration in Portage Creek drops down to 5.50 mg/kg. The expected post-removal concentration for the entire study area of Portage Creek is 1.88 mg/kg (see Table 2). (See section "Post-Remediation Expectations" below for more detail about Table 2.)

Looking at Table 1, SA1-A has the highest surface-weighted average for PCB with 29.50 mg/kg, followed by SA7 with 24.09 mg/kg. Remediation areas SA1-B and SA1-C had surface-weighted average concentrations of 23.47 and 23.43 mg/kg, respectively. SA5-C had the lowest surface-weighted average concentration, 0.41 mg/kg, for all remediation areas. For the non-remediated areas, Table 1 shows the surface-weighted average concentration for PCBs ranged from as low as 0.74 mg/kg across NRSA5-D to as high as 7.16 mg/kg across NRSA5-A (see Figure 1).

Estimated PCB Volume and Mass

The estimated total volume for PCB-containing sediment across all excavation areas was 16,567 yd^3; the estimated total mass of PCBs was 1,935 lbs. A breakdown of these estimates for each remediation area is shown in Tables 3 and 4.

The two most upstream remediation areas, SA6 and SA7, had an estimated volume of 2,737 yd^3 and 826 yd^3, respectively, of which 26 yd^3 and 101 yd^3, respectively, was estimated to contain TSCA material (Table 3). The estimated mass of PCB in remediation areas SA6 and SA7 is 55 lbs and 35 lbs, respectively. SA6 accounts for 16.5% of the total volume, 0.6% of the total TSCA volume, and 2.8% of the total PCB mass removed across all of the Portage Creek remediation areas, while SA7 accounts for 5.0% of the total volume, 2.5% of the total TSCA volume, and 1.8% of the total PCB mass removed (see Table 4). A further breakdown of these estimates by excavation area for these remediation areas can be seen in Figure 2. The excavation areas in Figure 2 also show the proposed removal depths by excavation area.

The majority of the total estimated PCB mass is contained within the midstream portion of Portage Creek (SA5-A, SA5-C, SA5-D, and Axtell Creek). Table 3 shows that remediation areas SA5-A and SA5-C had the two highest PCB mass estimates, with 876 lbs and 533 lbs,

respectively (accounting for 72.9% of the total mass). These two areas have estimated volumes of 2,086 yd^3 and 2,040 yd^3, respectively, accounting for approximately 24.9% of the estimated total volume in the remediation areas. Excavation area SA5-A5 had the largest PCB mass estimate across all of Portage Creek with 189.90 lbs (see Figure 3). A further breakdown of these estimates by excavation area for the midstream section can be seen in Figure 3. Figure 3 also shows the proposed removal depths by excavation area.

Looking at the remediation areas in the downstream portion of Portage Creek (see Figures 4 and 5), the combined estimated total volume for SA1-A, SA1-B, SA1-C, and SA3-A was 4,149 yd^3, of which 590 yd^3 was estimated to contain TSCA material, and the estimated PCB mass (TSCA and non-TSCA) was 184 lbs (see Table 3). Of these remediation areas, SA1-A contained the largest PCB mass estimate with 108 lbs, or approximately 5.6% of the estimated total PCB mass (see Tables 3 and 4). SA1-A also had the largest total volume and TSCA volume estimates (1,930 yd^3 and 414 yd^3 respectively) within this section of Portage Creek (see Table 3). Figures 4 and 5 also provide a breakdown of these estimates by excavation area for these remediation areas. Additionally, these figures show the proposed removal depths for each excavation area. For example, excavation area SA1-A3 has a proposed removal depth of 40 inches and the largest PCB mass estimate with 27.88 lbs for all excavation areas in these figures (see Figure 5).

Post-Remediation Expectations

It is expected that clean backfill will be added to remediated areas. The PCB concentration in this clean backfill is assumed to have a PCB detection limit of 0.33 mg/kg. As such, the post-removal PCB surface-weighted average concentration across all of Portage Creek is expected to be 1.88 mg/kg and 1.84 mg/kg for only the creek portion (see Table 2). The total estimated mass of PCB remaining after adding clean backfill in the remediated sections of Portage Creek is estimated to be approximately 13.8 pounds (see Table 5). A breakdown of the mass of PCB remaining after adding clean backfill within each remediation area across Portage Creek is given in Table 5.

Caveat

One note of consideration is that the current Portage Creek remediation and non-remediation area boundaries are based on floodplain boundary estimates. Additionally, the mass estimates for SA5-A and SA5-C were generated from very few sample locations within these remediation areas (five for SA5-A and two for SA5-C). With more sampling, PCB surface-weighted average concentration and mass estimates may increase or decrease within the remediation areas.

Contact

Please contact the FIELDS Group's John Canar (canar.john@epa.gov) about this document.

Remediation Areas	Area (ft^2)	PCB Surface-Weighted Average Concentration (mg/kg) from 0-6 inches
SA1-A	19,812	29.50
SA1-B	1,315	23.47
SA1-C	7,961	23.43
SA3-A	17,991	0.94
SA5-A	14,078	9.88
SA5-C*	14,210	0.41
SA5-D	36,625	2.03
SA6	31,427	3.48
SA7	11,153	24.09
Axtell Creek	10,335	18.13
Total: Remediated Areas	**164,907**	**9.72**
Non-Remediated Areas	**Area (ft^2)**	**PCB Surface-Weighted Average Concentration (mg/kg) from 0-6 inches**
NRSA1-A	14,677	4.11
NRSA1-B	7,879	4.78
NRSA2	24,856	6.39
NRSA3-A	3,858	2.39
NRSA3-B	13,791	2.14
NRSA4	48,569	1.34
NRSA5-A	2,182	7.16
NRSA5-B	11,014	2.23
NRSA5-C	2,634	0.87
NRSA5-D*	3,485	0.74
NRSA6	1,653	2.47
NRSA7	67,143	3.10
Total: Non-Remediated Areas	**201,741**	**3.07**
Total: Portage Creek	**366,648**	**6.06**
Total: Portage Creek minus SA7**	**355,495**	**5.50**

Table 1: Pre-Remediation PCB Surface-Weighted Average Concentrations across Portage Creek Remediation and Non-remediation Areas

* The PCB surface weighted averages for SA5-C and NRSA5-D may not be representative of the actual PCB concentration at the surface due to a dearth of sample points used for interpolation.

** This PCB surface weighted average was calculated to give a sense of what is only in the sediment, as SA7 is located outside of the Portage Creek boundary.

NOTE: Areas' boundaries will be redefined during reconnaissance and removal work; hence, Surface-Weighted Average Concentrations, Volumes, and Mass values presented here will likely be adjusted.

Remediation Areas	**Area (ft^2)**	**PCB Post-Remediation Concentration (mg/kg) from 0-6 inches**
SA1-A	19,812	0.33
SA1-B	1,315	*0.33*
SA1-C	7,961	0.33
SA3-A	17,991	0.33
SA5-A	14,078	0.33
SA5-C	14,210	0.33
SA5-D	36,625	0.33
SA6	31,427	0.33
SA7	11,153	0.33
Axtell Creek	10,335	0.33
Non-Remediated Areas	**Area (ft^2)**	**PCB Post-Remediation Concentration (mg/kg) from 0-6 inches**
NRSA1-A	14,677	4.11
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NRSA5-B	11,014	2.23
NRSA5-C	2,634	0.87
NRSA5-D	3,485	0.74
NRSA6	1,653	2.47
NRSA7	67,143	3.10
Total: Portage Creek	**366,648**	**1.84**
Total: Portage Creek minus SA7	**355,495**	**1.88**

Table 2: Post-Remediation PCB Surface-Weighted Average Concentrations across Portage Creek Remediation and Non-remediation Areas

NOTE: Areas' boundaries will be redefined during reconnaissance and removal work; hence, Surface-Weighted Average Concentrations, presented here will likely be adjusted.

Remediation Areas	Total Volume (yd^3)	Total TSCA Volume (yd^3)	Total Mass All PCB (lbs)
SA1-A	1,930	414	108
SA1-B	47	47	3
SA1-C	506	129	34
SA3-A	1,666	0	39
SA5-A	2,086	951	876
SA5-C	2,040	1,448	533
SA5-D	3,880	665	186
SA6	2,737	26	55
SA7	826	101	35
Axtell Creek	849	333	66
Total	**16,567**	**4,114**	**1,935**

Table 3: Pre-Remediation PCB Mass and Volume Estimates by Remediation Area

NOTE: Areas' boundaries will be redefined during reconnaissance and removal work; hence, volumes and mass values presented here will likely be adjusted.

Remediation Areas	Percent Total Volume (yd^3)	Percent Total TSCA Volume (yd^3)	Percent Total Mass All PCB (lbs)
SA1-A	11.7%	10.1%	5.6%
SA1-B	0.3%	1.1%	0.2%
SA1-C	3.1%	3.1%	1.8%
SA3-A	10.1%	0.0%	2.0%
SA5-A	12.6%	23.1%	45.3%
SA5-C	12.3%	35.2%	27.6%
SA5-D	23.4%	16.2%	9.6%
SA6	16.5%	0.6%	2.8%
SA7	5.0%	2.5%	1.8%
Axtell Creek	5.1%	8.1%	3.4%
Total	100%	100%	100%

Table 4: Pre-Remediation PCB Mass and Volume Percentage Estimates by Remediation Area

NOTE: Areas' boundaries will be redefined during reconnaissance and removal work; hence, volumes and mass values presented here will likely be adjusted.

Remediation Areas	Estimated Total Mass of PCB (lbs) (Post-Remediation)
SA1-A	1.59
SA1-B	0.04
SA1-C	0.42
SA3-A	1.37
SA5-A	1.72
SA5-C	1.68
SA5-D	3.61
SA6	1.99
SA7	0.68
Axtell Creek	0.68
Total	**13.78**

Table 5: Post-Remediation PCB Mass Remaining Estimates by Remediation Area

NOTE: Areas' boundaries will be redefined during reconnaissance and removal work; hence, mass values presented here will likely be adjusted.

Figure 1: Remediation and Non-Remediation Area Boundaries within Portage Creek

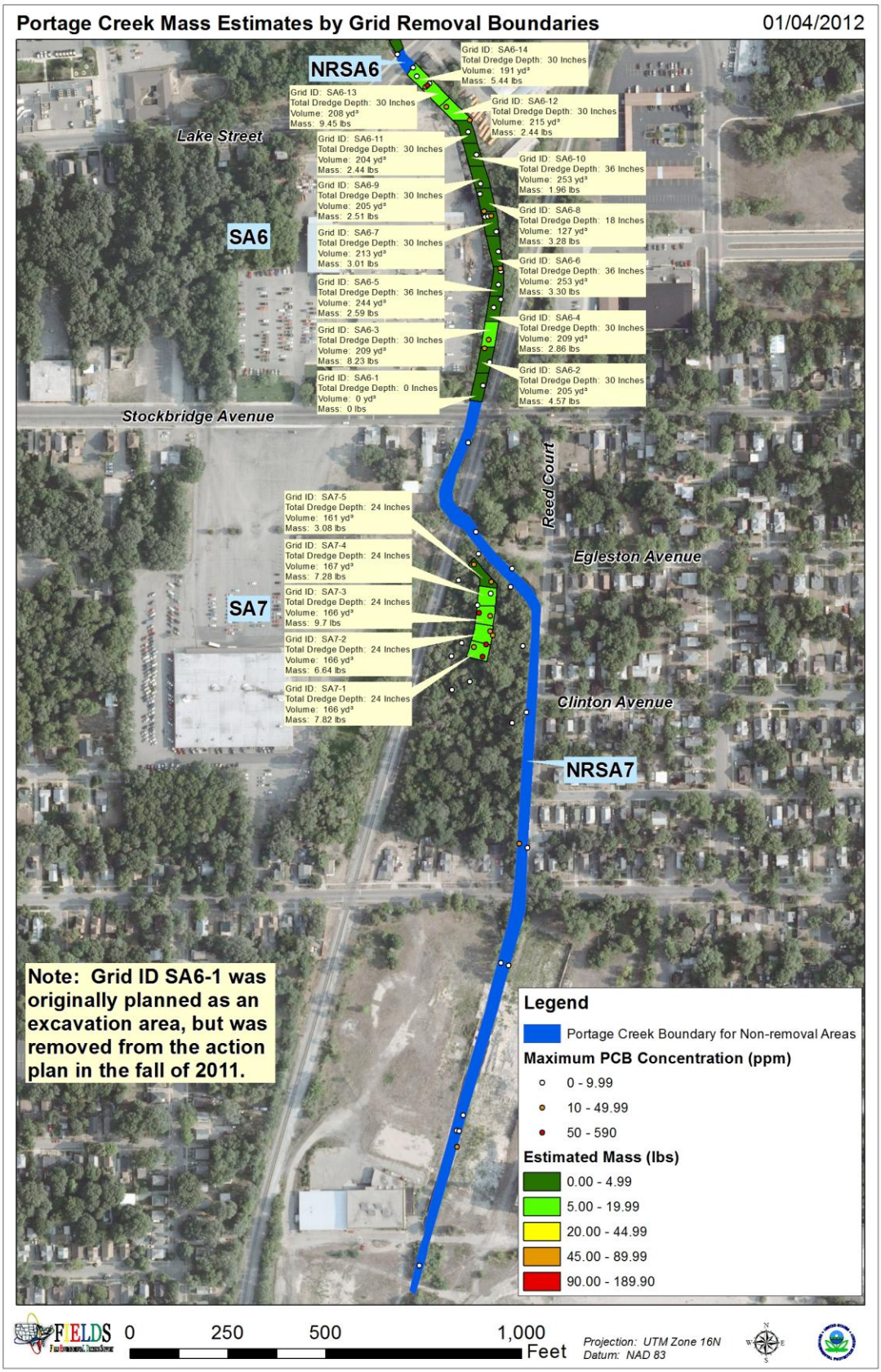

Figure 2: PCB Mass and Volume Estimates in the upstream section of Portage Creek (SA6 and SA7).

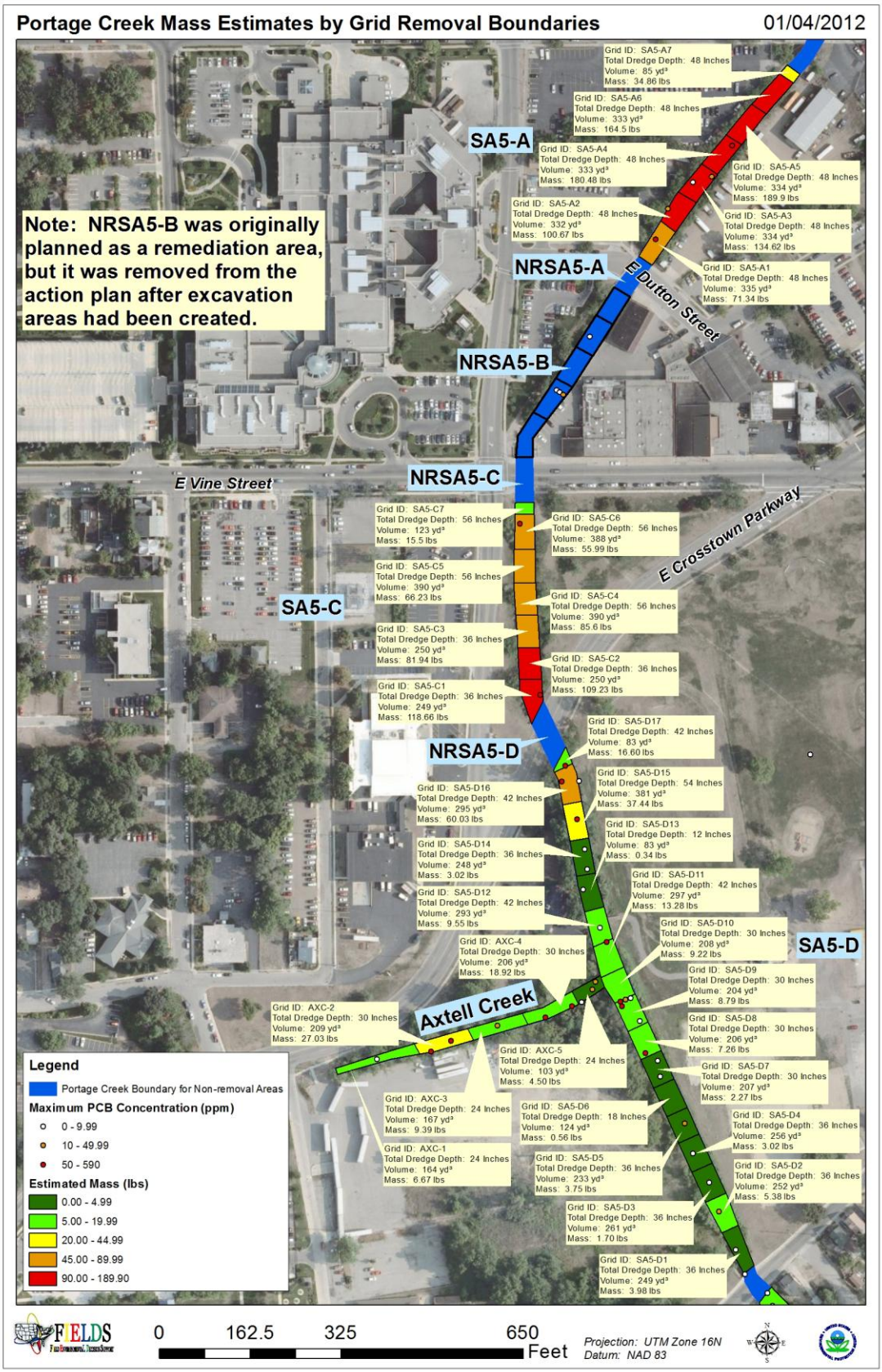

Figure 3: PCB Mass and Volume Estimates in the midstream section of Portage Creek (SA5-A, SA5-C, SA5-D, and Axtell Creek).

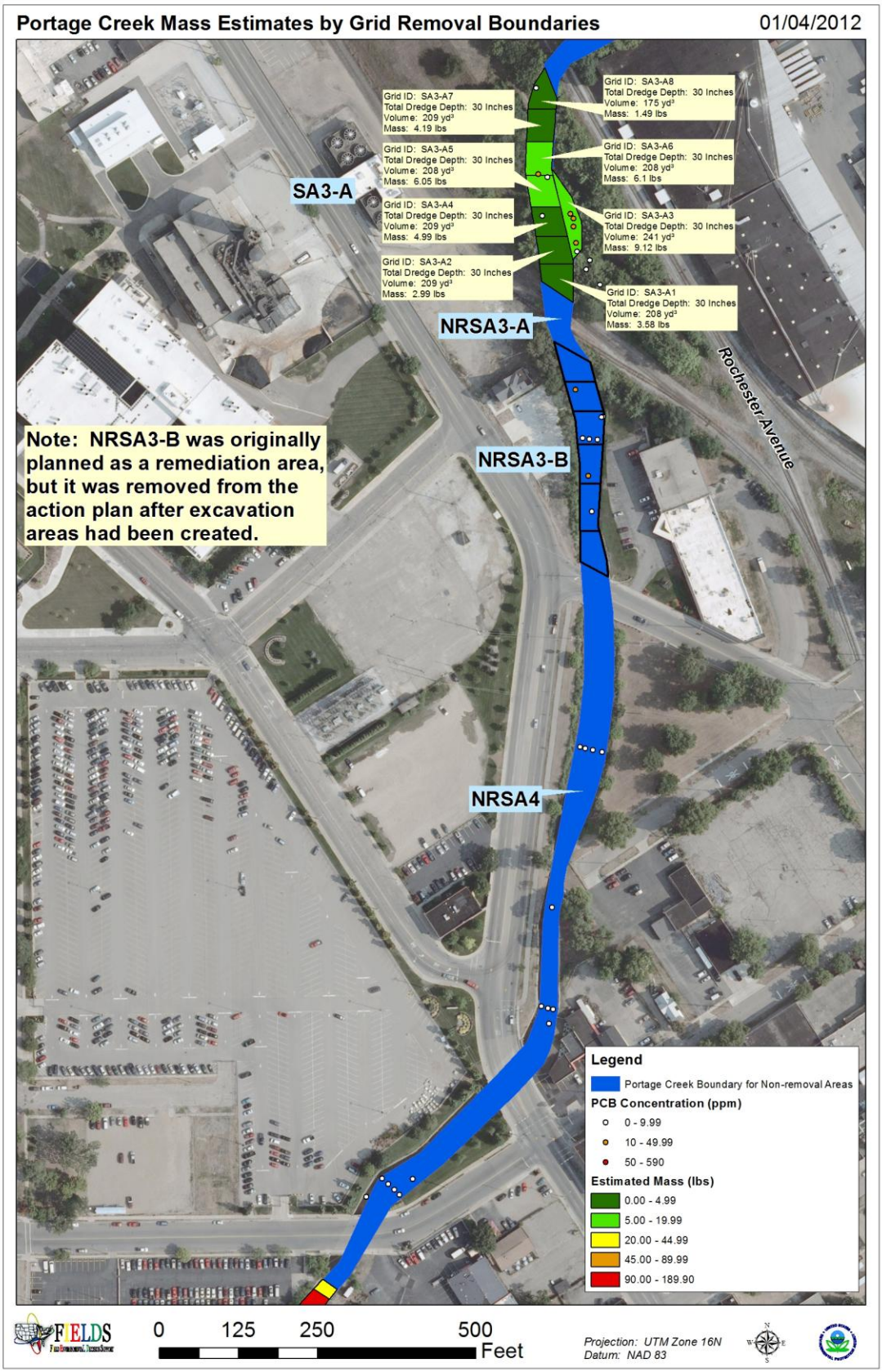

Figure 4: PCB Mass and Volume Estimates in the downstream section of Portage Creek (SA3-A).

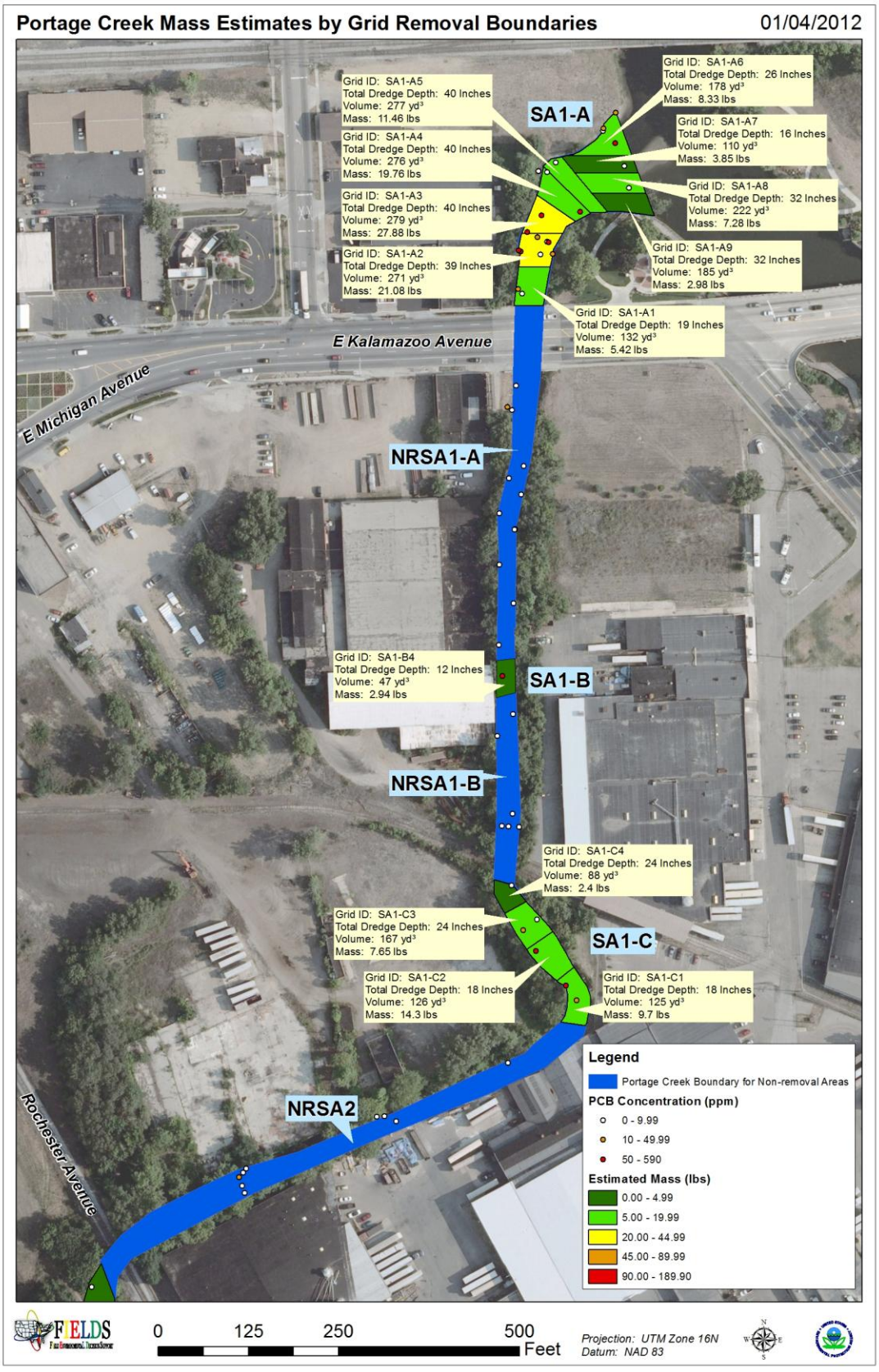

Figure 5: PCB Mass and Volume Estimates in the downstream section of Portage Creek (SA1-A, SA1-B, and SA1-C).